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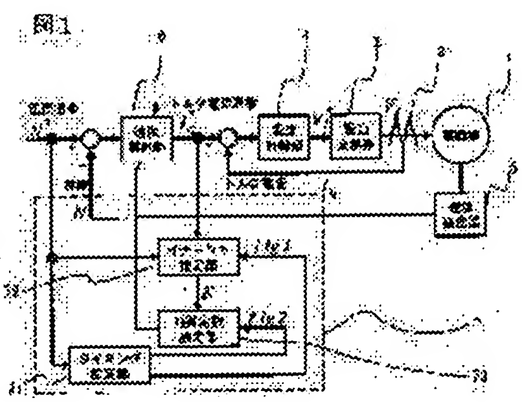
(54) ONLINE AUTOTUNING SERVO CONTROLLER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a servo controller realizing high performance positioning by performing highly accurate inertia estimation even upon occurrence of a load inertia variation during actual operation and correcting the set constant at a speed control section automatically.



SOLUTION: An inertia estimation value is determined from a torque command value and a speed command value if the variation of the speed command value is not lower than a specified value and the set constant at a speed control section is corrected automatically based on the inertia estimation value thus determined if the variation of the speed command value is not higher than the specified value. Furthermore, 'load torque variation' and 'torque current limitation' are detected at the time of operating inertia estimation and the set constant at the speed control section is corrected automatically based on the inertia estimation value before detection.

LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The power converter which drives a motor, and the speed-control section which acquires a torque current command value according to the deflection of a rate command value and a speed detection value, In the servo control of the motor equipped with the current control section which controls the output current of said power converter according to this torque current command value Perform the presumed operation of the machine inertia which will be connected to said motor if a rate command value or speed detection value-change width of face is beyond a predetermined value, calculate inertia estimate, and if a rate command value or speed detection value-change width of face is below a predetermined value The online auto tuning servo control characterized by having the means which makes the automatic correction of the setting constant of the speed-control section based on this inertia estimate.
[Claim 2] The power converter which drives a motor, and the position control section which acquires a rate command value according to the deflection of a location command value and a location detection value, In the servo control of the motor equipped with the speed-control section which acquires a torque current command value according to the deflection of this rate command value and a speed detection value, and the current control section which controls the output current of said power converter according to this torque current command value If the differential value of a location command value or rate command value-change width of face is beyond a predetermined value Perform the presumed operation of the machine inertia connected to said motor, calculate inertia estimate, and if the differential value of a location command value or rate command value-change width of face is below a predetermined value The online auto tuning servo control characterized by having the means which makes the automatic correction of the setting constant of the speed-control section based on this inertia estimate.
[Claim 3] The online auto tuning servo control characterized by having a means to calculate said inertia estimate by the operation in the servo control of claim 1 or claim 2 based on the ratio of the acceleration-and-deceleration torque estimate calculated using the torque current command value or the torque current detection value, and the differential value of a rate command value or the differential value of a speed detection value.
[Claim 4] The online auto tuning servo control characterized by having a means to subtract and calculate a torque current command value in case the differential value of a torque current command value or a torque current detection value to a location command value or rate command value-change width of face is below a predetermined value about said acceleration-and-deceleration torque estimate, or a torque current detection value in the servo control of claim 3.
[Claim 5] The online auto tuning servo control characterized by having the means which considers the differential value of a location command value, or the predetermined value of rate command value-change width of face as abbreviation 0 in the servo control of claim 1 thru/or either of 4.
[Claim 6] The power converter which drives a motor, and the speed-control section which acquires a torque current command value according to the deflection of a rate command value and a speed detection value, In the servo control of the motor equipped with the current control section which controls the output current of said power converter according to this torque current command value If a rate command value or speed detection value-change width of face is beyond a predetermined value, the presumed operation of the machine inertia connected to said motor will be performed. Calculate inertia estimate, calculate load torque estimate using a torque current command value or a torque current detection value, and if this load torque estimate is beyond a predetermined value It is the online auto tuning servo control characterized by having the means which makes the automatic correction of the setting constant of the speed-control section using the inertia estimate which did not perform parameter input of the speed-control section

using said inertia estimate, but was calculated when said load torque estimate was below a predetermined value.
[Claim 7] The online auto tuning servo control characterized by having the means searched for by subtracting the value to which the differential value of a torque current command value or a torque current detection value to a rate command value or the differential value of a speed detection value, and said inertia estimate carried out the multiplication of said load torque estimate in the servo control of claim 6.
[Claim 8] The power converter which drives a motor, and the speed-control section which acquires a torque current command value according to the deflection of a rate command value and a speed detection value, In the servo control of the motor equipped with the current control section which controls the output current of said power converter according to this torque current command value Perform the presumed operation of the machine inertia which will be connected to said motor if a rate command value or speed detection value-change width of face is beyond a predetermined value, calculate inertia estimate, and if a torque current command value or a torque current detection value is beyond a predetermined value Parameter input of the speed-control section is not performed using said inertia estimate. The online auto tuning servo control characterized by having the means which makes the automatic correction of the setting constant of the speed-control section using the inertia estimate calculated when said torque current command value or a torque current detection value was below a predetermined value.
[Claim 9] The online auto tuning servo control characterized by making the predetermined value of said torque current command value or a torque current detection value into the limiting value of the speed-control section in the servo control of claim 8.

[Translation done.]

* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In control units, such as an industrial machine (semiconductor fabrication machines and equipment, a machine tool, injection molding machine), this invention presumes the inertia of a machine during real operation, and relates to the control unit which makes the automatic correction of the controlled parameter of the speed-control section.
[0002]
[Description of the Prior Art] As for the inertia (henceforth, load inertia) value of the machine used in case the controlled parameter of the speed-control section is calculated conventionally, it is common to make a test run with a predetermined operation pattern, before performing real operation, and to compute from the relation of the generating torque of a motor, acceleration-and-deceleration time amount, and rotational speed. However, when changing a load inertia value during real operation, the controlled parameter of the speed-control section could not be set up appropriately, but there was a problem which causes the degradation at the time of positioning (overshoot size, settling-time fault size, etc.).
[0003] In addition, there is JP,61-88780,A as a related patent of inertia presumption at the time of a pilot run.
[0004]
[Problem(s) to be Solved by the Invention] The purpose of this invention is by performing highly precise inertia presumption, when load inertia fluctuation arises during real operation, and making the automatic correction of the setting constant of the speed-control section to offer the servo control which realizes highly efficient positioning.
[0005]
[Means for Solving the Problem] The description of this invention of attaining the above-mentioned purpose is making the automatic correction of the setting constant of the speed-control section based on the inertia estimate which calculated inertia estimate from the torque current command value and the rate command value when rate command value-change width of face's was beyond a predetermined value, and was calculated when said rate command value-change width of face's was below a predetermined value. Furthermore, "load torque fluctuation" and "torque current limiting" are detected at the time of an inertia presumption operation, and it is characterized by making the automatic correction of the setting constant of the speed-control section based on the inertia estimate before detection in the case of detection.
[0006]
[Embodiment of the Invention] Hereafter, the example of this invention is explained to a detail using a drawing.
[0007] Drawing 1 shows the example of a configuration of the online auto tuning servo control of the motor which is one example of this invention.
[0008] The power converter which outputs the output voltage V1 to which 1 was proportional to a motor and 2 is proportional to electrical-potential-difference command value V1*, and drives a motor 1, The current detector which detects the torque current value Iq whose 3 is the output of a power converter 2, The current control section to which 4 calculates V1* according to the deflection of torque current command value Iq* and the torque current detection value Iq, The rate detector with which 5 detects the rate N of a motor 1, the speed-control section which 6 inputs the deflection signal of rate command value N* and the speed detection value N, and outputs torque current command value Iq*, 7 is the online auto tuning section which inputs rate command value N* and torque current command value

Iq*, and makes the automatic correction of the control-point-setting constant of the speed-control section 6.
[0009] The online auto tuning section 7 consists of the timing setting section 71, the inertia presumption section 72, and the controlled parameter setting section 73.
[0010] In the timing setting section 71, a timing signal flg2 is outputted for a timing signal flg1 to the control-point-setting section 73 at the inertia presumption section 72 according to rate command value N*. In the inertia presumption section 72, from rate command value N* and torque current command value Iq*, and a timing signal flg1, the presumed inertia ratio K is outputted and the setting constant of the speed-control section 6 is corrected using the presumed inertia ratio K and a timing signal flg2 by the controlled parameter setting section 73.
[0011] Next, the online auto tuning section 7 which is the characteristic configuration of this invention is explained to a detail. First, the configuration of the timing setting section 71 is explained using drawing 2 .
[0012] Rate command value N* inputted into the timing setting section 71 is inputted into the sample hold machine 711, by 711, outputs command value N* in front of 1 sampling period (n-1), and is inputted into a subtractor 712 with rate command value N*. In a comparator 713, output deltaN* of a subtractor 712 and rate change width-of-face set point deltaN*set are inputted, and a timing signal flg1 and a timing signal flg2 are outputted. The property of these signals is as follows.
[0013]
: the case of deltaN*>deltaN*set -- flg 2 = 1 -- in addition to this, use drawing 3 for flg2 = zero-order, and explain a series of timing of the timing setting section 71, the inertia presumption section 72, and the controlled parameter setting section 73 of operation. : Case of flg1 = 1deltaN*<=deltaN*set: flg 1 = 0 -- the moment that flg1 is set to "0" from "1" again :
[0014] First, if the presumed inertia ratio K is calculated in the inertia presumption section 72 and rate command value N* goes into a 1 fixed-speed condition when rate command value N* is in an acceleration-and-deceleration condition (the timing signal flg1 in drawing the section of "1" : inertia presumption section) (the timing signal flg1 in drawing is the section of "0"), the operation of the presumed inertia ratio K will be ended. Moreover, it is reflected until it is the section (controlled parameter setting section) which corrects a controlled parameter based on the above-mentioned presumed inertia ratio K, it corrects the controlled parameter of the speed-control section 6 based on this corrective action and the next inertia presumption actuation is completed from from, when a timing signal flg1 is set to "0" from "1" (a points of drawing) (to b points of drawing where a timing signal flg1 becomes "0" from "1" next). And based on the presumed inertia ratio K newly presumed that inertia presumption actuation is completed in b points, the controlled parameter of the speed-control section 6 is corrected like last time.
[0015] Furthermore, the configuration of the inertia presumption section 72 which performs inertia presumption on the basis of the above-mentioned timing signal flg1 is explained using drawing 4 . Torque current command value Iq* inputted into the inertia presumption section 72 is inputted into sample hold machine 721A with a timing signal flg1. In 721A, the condition of a timing signal flg1 is seen and signal Iq*hold holding torque current command value Iq* is outputted. The timing holding torque current command value Iq* is the moment that a timing signal flg1 is set to "1" from "0." Retention-data Iq*hold is inputted into a subtractor 722 with torque current command value Iq*, and outputs signal deltaIq* in a subtractor 722. On the other hand, rate command value N* is inputted into a differentiator 725, and the output of a differentiator 725 is inputted into a multiplier 723 with the simple substance inertia value Jm0726 of a motor 1, and outputs signal deltaIq0* in a multiplier 723. Moreover, signal deltaIq0* is inputted into a divider 724 with output signal deltaIq* of a subtractor 722, and the output of a divider 724 is inputted into sample hold circuit 721B with a timing signal flg1. In sample hold circuit 721B, the output signal of a divider 724 is held at the moment of a timing signal flg1 being set to "0" from "1", and the presumed inertia ratio K is outputted.
[0016] Moreover, 2 of an "acceleration-and-deceleration torque component" and a "load torque component" components are contained in torque current command value Iq*, and inertia information is included in it above "an acceleration-and-deceleration torque component." In order to compute an exact inertia value, it is necessary to eliminate a "load torque component" from torque current command value Iq* in inertia presumption operation part.
[0017] Next, the timing which eliminates this "load torque component" using drawing 5 is explained. In the condition that rate command value N* will be in a 1 fixed-speed condition (the timing signal flg1 in drawing is the section of "0"), since an "acceleration-and-deceleration torque component" serves as zero, torque current command value Iq* becomes a "load torque component." Then, torque current command value Iq* just before inertia presumption actuation is started (the moment that the timing signal flg1 in drawing is set to "1" from "0") can be made into estimate Iq*hold

of a "load torque component", and "acceleration-and-deceleration torque component" deltaIq* can be computed by subtracting this value from torque current command value Iq*.
[0018] Here, explanation of the calculation approach of the presumed inertia ratio K shows signal deltaIq* generated during acceleration and deceleration by (several 1).
[0019]
deltaIq*=K1andJ-deltan/deltat ..... (1)
here -- K1:transform coefficient J: -- the synthetic inertia value of a motor and a load machine -- signal deltaIq0* generated when based on deltan:rate change part deltat:change time amount one side and the simple substance inertia value Jm0726 of a motor 1 is shown by (several 2).
[0020]
deltaIq0*=K1, Jm0, anddeltan/deltat ..... (2)
Then (several 3), it can ask for the presumed inertia ratio K by performing the shown operation.
[0021]
K=deltaIq*/deltaIq0* ..... (3) The configuration of the controlled parameter setting section 73 which makes the automatic correction of the setting constant of the speed-control section using the presumed inertia ratio K on the basis of the further above-mentioned timing signal flg2 is explained using drawing 6 .
[0022] The multiplication of the presumed inertia ratio K inputted into the controlled parameter setting section 73 is respectively carried out with Multipliers 732A and 732B, and it is respectively inputted [gain / Ksi0 / of the example gain 0 and Ksp 734 of a critical ratio of 733 / criteria integral] into sample hold circuits 731A and 731B with a timing signal flg2. In sample hold circuits 731A and 731B, the output signal of Multipliers 732A and 732B is held at the moment of a timing signal flg2 being respectively set to "1" from "0", and a controlled parameter (proportional gain Ksp, integral gain Ksi) is outputted.
[0023] The operation shown by (several 4) performs a controlled parameter.
[0024]
Ksp=K-Ksp0 Ksi=K-Ksi0 ..... (4)
The automatic correction of the controlled parameter of the speed-control section 6 is made using this controlled parameter (Ksp, Ksi).
[0025] Next, this example of a series of of operation is shown in drawing 7 and drawing 8 .
[0026] The example of drawing 7 of operation is a thing when not performing online auto tuning (Ksp=Ksp0, Ksi=Ksi0), in order to see the effectiveness of the online auto tuning section 7 which is the description of this invention. In this example of operation, since it is carrying out by 5 times the simple substance inertia value Jm0726 of the motor 1 which shows a load inertia value to drawing 1 , the synthetic inertia value J becomes 6 times. When it carries out adjustable [of rate command value N*] by operation pattern which is illustrated, it turns out that the flattery nature of a rate N has deteriorated.
[0027] Here, the example of drawing 8 of operation is a thing at the time of performing the online auto tuning which is the description of this invention (Ksp=K-Ksp0, Ksi=K-Ksi0). Auto tuning is started from c points. It turns out [whose presumed inertia ratio K is a real inertia ratio (J/Jm0)] that is converged 6 times promptly. Furthermore, by correcting the controlled parameter of the speed-control section 6 also shows that the rate N follows rate command value N* well.
[0028] said example ****** -- inertia presumption -- working -- setting -- the auto tuning method about [when load torque is fixed] -- it is -- inertia presumption -- if it sets working and load torque is changed, an error will arise in signal deltaIq* which is an "acceleration-and-deceleration torque component", and, as a result, inertia presumption precision will fall.
[0029] Then, a control-point-setting constant is corrected using the presumed inertia ratio K calculated when torque fluctuation was below a predetermined value, without using the presumed inertia ratio K then calculated, when load torque estimate is computed using rate command value N* and torque current command value Iq* in drawing 1 , and the presumed inertia ratio K and the torque fluctuation beyond a predetermined value is detected during inertia presumption actuation. Inertia presumption precision can be made high by performing this load torque fluctuation compensation.
[0030] This example is shown in drawing 9 . This example is an example which formed the load torque fluctuation detecting element 74 in the online auto tuning servo control of the motor of drawing 1 , and applied load torque fluctuation compensation to it. In drawing, 1-6, and 71 and 73 are the same objects as the thing of drawing 1 . 74 is a

load torque fluctuation detecting element which detects torque fluctuation using rate command value N* and torque current command value Iq*, and the presumed inertia ratio K, and an output signal flg3 is as follows.
[0031]
負荷トルクの変動を検出した場合 : $flg_3 = 1$
〃 を検出しない場合 : $flg_3 = 0$

Next, the load torque fluctuation detecting element 74 which is the characteristic configuration of this invention is explained using drawing 10 . Rate command value N* inputted into the load torque fluctuation detecting element 74 is inputted into a differentiator 746, the output is inputted into multiplier 745A with the simple substance inertia value Jm0 of the motor 1 of 747, and both the output and the presumed inertia ratio K are inputted into multiplier 745B, by multiplier 745B, they output "estimate of acceleration-and-deceleration component" signal taum, and are inputted into a subtractor 741 with torque current command value Iq*. The output of a subtractor 741 is set to "estimate of load torque component" signal tauL, it is inputted into an absolute-value circuit 742, and the output is inputted into the first-order-lag circuit 743.
[0032] With the output of an absolute-value circuit 742, the output of the first-order-lag circuit 743 is inputted into a subtractor 744, and the output deltatauL is inputted into a comparator 749 with the load torque change width-of-face set point deltatauLset of 748. The signal flg3 outputted in a comparator 749 is as follows.
[0033]
deltatauL>deltatauLset Case: flg3= 1 deltatauL<=deltatauLset Case: flg 3= 0 -- further -- inertia presumption section 72A -- inertia presumption -- being working (section of flg 1 = 1) -- when flg 3= 1 is detected, the presumed inertia ratio K calculated at the time of flg 3= 0, without using the presumed inertia ratio K calculated at this time is used.
[0034] Next, this example of a series of of operation is shown in drawing 11 and drawing 12 .
[0035] The example of drawing 11 of operation is a thing at the time of not performing load-effect compensation, in order to see the effectiveness of load-effect compensation which is the description of this invention (when deltatauLset of the load torque change width-of-face set point 748 shown in drawing 10 is set to 300 [%]). In this example of operation, the load torque of 100 [%] is impressed in d in inertia presumption actuation. d-point after -- setting -- the presumed inertia ratio K -- 6 times of a true value -- being excessive (9 times) -- it turns out that it has become.
[0036] Here, the example of operation at the time of applying this invention is shown in drawing 12 . Drawing 12 is a thing at the time of performing load-effect compensation which is the description of this invention (it being deltatauLset 10 [%]). Also in this example of operation, the load torque of 100 [%] is impressed in d'point under inertia presumption actuation. this example of operation -- d' -- since it is being completed by the presumed inertia ratio K 6 times of a true value after a point, inertia presumption precision can be made high by performing load torque fluctuation compensation.
[0037] Moreover, said example is an auto tuning method when torque current command value Iq* has not reached during inertia presumption actuation at a current-limiting value, and if torque current command value Iq* reaches during inertia presumption actuation at a current-limiting value, inertia presumption precision will fall like a last example.
[0038] Then, a control-point-setting constant is corrected using the presumed inertia ratio K calculated when torque current command value Iq* was below a current-limiting value, without using the presumed inertia ratio K then calculated, when torque current command value Iq* in drawing 1 reaches a current-limiting value. Inertia presumption precision can be made high by performing this torque current-limiting compensation.
[0039] This example is shown in drawing 13 . This example is an example which formed the torque current-limiting detecting element 75 in the online auto tuning servo control of the motor of drawing 9 R> 9. In drawing, 1-6, and 71, 73 and 74 are the same as that of the thing of drawing 9 . 75 is a torque current-limiting detecting element which detects current limiting using torque current command value Iq*, and an output signal flg4 is as follows.
[0040]
When current limiting is detected : :flg4= when flg4= 1 current limiting is not detected The torque current-limiting detecting element 75 which is the characteristic configuration of this invention is explained to zero-order using drawing 14 . Torque current command value Iq* inputted into the torque current-limiting detecting element 75 is inputted into an absolute-value circuit 751, and the output is inputted into a comparator 753 with torque current command limiting

value Iq*lim of 752. The signal flg4 outputted in a comparator 753 is as follows.
[0041]
| Iq*|>=Iq*lim: flg 4= 0 -- further -- inertia presumption section 72b -- inertia presumption -- being working (section of flg 1 = 1) -- when flg 4= 1 is detected, use the presumed inertia ratio K computed at the time of flg 4= 0, without using the presumed inertia ratio K calculated at this time. Case: flg4= 1|Iq*|<Iq*lim Case
[0042] In this invention, even when torque current command value Iq* reaches during inertia presumption actuation at a current-limiting value, inertia presumption precision can be made high by performing torque current-limiting compensation.
[0043]
[Effect of the Invention] According to this invention, the servo control which realizes highly efficient positioning can be offered by performing highly precise inertia presumption, when load inertia fluctuation arises during real operation, and making the automatic correction of the setting constant of the speed-control section.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] In control units, such as an industrial machine (semiconductor fabrication machines and equipment, a machine tool, injection molding machine), this invention presumes the inertia of a machine during real operation, and relates to the control unit which makes the automatic correction of the controlled parameter of the speed-control section.

[Translation done.]

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PRIOR ART

[Description of the Prior Art] As for the inertia (henceforth, load inertia) value of the machine used in case the controlled parameter of the speed-control section is calculated conventionally, it is common to make a test run with a predetermined operation pattern, before performing real operation, and to compute from the relation of the generating torque of a motor, acceleration-and-deceleration time amount, and rotational speed. However, when changing a load inertia value during real operation, the controlled parameter of the speed-control section could not be set up appropriately, but there was a problem which causes the degradation at the time of positioning (overshoot size, settling-time fault size, etc.).
[0003] In addition, there is JP,61-88780,A as a related patent of inertia presumption at the time of a pilot run.

[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, the servo control which realizes highly efficient positioning can be offered by performing highly precise inertia presumption, when load inertia fluctuation arises during real operation, and making the automatic correction of the setting constant of the speed-control section.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] The purpose of this invention is by performing highly precise inertia presumption, when load inertia fluctuation arises during real operation, and making the automatic correction of the setting constant of the speed-control section to offer the servo control which realizes highly efficient positioning.

[Translation done.]

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MEANS

[Means for Solving the Problem] The description of this invention of attaining the above-mentioned purpose is making the automatic correction of the setting constant of the speed-control section based on the inertia estimate which calculated inertia estimate from the torque current command value and the rate command value when rate command value-change width of face's was beyond a predetermined value, and was calculated when said rate command value-change width of face's was below a predetermined value. Furthermore, "load torque fluctuation" and "torque current limiting" are detected at the time of an inertia presumption operation, and it is characterized by making the automatic correction of the setting constant of the speed-control section based on the inertia estimate before detection in the case of detection.
[0006]
[Embodiment of the Invention] Hereafter, the example of this invention is explained to a detail using a drawing.
[0007] Drawing 1 shows the example of a configuration of the online auto tuning servo control of the motor which is one example of this invention.
[0008] The power converter which outputs the output voltage V1 to which 1 was proportional to a motor and 2 is proportional to electrical-potential-difference command value V1*, and drives a motor 1, The current detector which detects the torque current value Iq whose 3 is the output of a power converter 2, The current control section to which 4 calculates V1* according to the deflection of torque current command value Iq* and the torque current detection value Iq, The rate detector with which 5 detects the rate N of a motor 1, the speed-control section which 6 inputs the deflection signal of rate command value N* and the speed detection value N, and outputs torque current command value Iq*, 7 is the online auto tuning section which inputs rate command value N* and torque current command value Iq*, and makes the automatic correction of the control-point-setting constant of the speed-control section 6.
[0009] The online auto tuning section 7 consists of the timing setting section 71, the inertia presumption section 72, and the controlled parameter setting section 73.
[0010] In the timing setting section 71, a timing signal flg2 is outputted for a timing signal flg1 to the control-point-setting section 73 at the inertia presumption section 72 according to rate command value N*. In the inertia presumption section 72, from rate command value N* and torque current command value Iq*, and a timing signal flg1, the presumed inertia ratio K is outputted and the setting constant of the speed-control section 6 is corrected using the presumed inertia ratio K and a timing signal flg2 by the controlled parameter setting section 73.
[0011] Next, the online auto tuning section 7 which is the characteristic configuration of this invention is explained to a detail. First, the configuration of the timing setting section 71 is explained using drawing 2 .
[0012] Rate command value N* inputted into the timing setting section 71 is inputted into the sample hold machine 711, by 711, outputs command value N* in front of 1 sampling period (n-1), and is inputted into a subtractor 712 with rate command value N*. In a comparator 713, output deltaN* of a subtractor 712 and rate change width-of-face set point deltaN*set are inputted, and a timing signal flg1 and a timing signal flg2 are outputted. The property of these signals is as follows.
[0013]
: the case of deltaN*>deltaN*set -- flg 2 = 1 -- in addition to this, use drawing 3 for flg2 = zero-order, and explain a series of timing of the timing setting section 71, the inertia presumption section 72, and the controlled parameter setting section 73 of operation. : Case of flg1 = 1deltaN*<=deltaN*set: flg 1 = 0 -- the moment that flg1 is set to "0" from "1" again :

[0014] First, if the presumed inertia ratio K is calculated in the inertia presumption section 72 and rate command value N* goes into a 1 fixed-speed condition when rate command value N* is in an acceleration-and-deceleration condition (the timing signal flg1 in drawing the section of "1" : inertia presumption section) (the timing signal flg1 in drawing is the section of "0"), the operation of the presumed inertia ratio K will be ended. Moreover, it is reflected until it is the section (controlled parameter setting section) which corrects a controlled parameter based on the above-mentioned presumed inertia ratio K, it corrects the controlled parameter of the speed-control section 6 based on this corrective action and the next inertia presumption actuation is completed from from, when a timing signal flg1 is set to "0" from "1" (a points of drawing) (to b points of drawing where a timing signal flg1 becomes "0" from "1" next). And based on the presumed inertia ratio K newly presumed that inertia presumption actuation is completed in b points, the controlled parameter of the speed-control section 6 is corrected like last time.
[0015] Furthermore, the configuration of the inertia presumption section 72 which performs inertia presumption on the basis of the above-mentioned timing signal flg1 is explained using drawing 4 . Torque current command value Iq* inputted into the inertia presumption section 72 is inputted into sample hold machine 721A with a timing signal flg1. In 721A, the condition of a timing signal flg1 is seen and signal Iq*hold holding torque current command value Iq* is outputted. The timing holding torque current command value Iq* is the moment that a timing signal flg1 is set to "1" from "0." Retention-data Iq*hold is inputted into a subtractor 722 with torque current command value Iq*, and outputs signal deltaIq* in a subtractor 722. On the other hand, rate command value N* is inputted into a differentiator 725, and the output of a differentiator 725 is inputted into a multiplier 723 with the simple substance inertia value Jm0726 of a motor 1, and outputs signal deltaIq0* in a multiplier 723. Moreover, signal deltaIq0* is inputted into a divider 724 with output signal deltaIq* of a subtractor 722, and the output of a divider 724 is inputted into sample hold circuit 721B with a timing signal flg1. In sample hold circuit 721B, the output signal of a divider 724 is held at the moment of a timing signal flg1 being set to "0" from "1", and the presumed inertia ratio K is outputted.
[0016] Moreover, 2 of an "acceleration-and-deceleration torque component" and a "load torque component" components are contained in torque current command value Iq*, and inertia information is included in it above "an acceleration-and-deceleration torque component." In order to compute an exact inertia value, it is necessary to eliminate a "load torque component" from torque current command value Iq* in inertia presumption operation part.
[0017] Next, the timing which eliminates this "load torque component" using drawing 5 is explained. In the condition that rate command value N* will be in a 1 fixed-speed condition (the timing signal flg1 in drawing is the section of "0"), since an "acceleration-and-deceleration torque component" serves as zero, torque current command value Iq* becomes a "load torque component." Then, torque current command value Iq* just before inertia presumption actuation is started (the moment that the timing signal flg1 in drawing is set to "1" from "0") can be made into estimate Iq*hold of a "load torque component", and "acceleration-and-deceleration torque component" deltaIq* can be computed by subtracting this value from torque current command value Iq*.
[0018] Here, explanation of the calculation approach of the presumed inertia ratio K shows signal deltaIq* generated during acceleration and deceleration by (several 1).
[0019]
deltaIq*=K1andJ-deltan/deltat ..... (1)
here -- K1:transform coefficient J: -- the synthetic inertia value of a motor and a load machine -- signal deltaIq0* generated when based on deltan:rate change part deltat:change time amount one side and the simple substance inertia value Jm0726 of a motor 1 is shown by (several 2).
[0020]
deltaIq0*=K1, Jm0, anddeltan/deltat ..... (2)
Then (several 3), it can ask for the presumed inertia ratio K by performing the shown operation.
[0021]
K=deltaIq*/deltaIq0* ..... (3) The configuration of the controlled parameter setting section 73 which makes the automatic correction of the setting constant of the speed-control section using the presumed inertia ratio K on the basis of the further above-mentioned timing signal flg2 is explained using drawing 6 .
[0022] The multiplication of the presumed inertia ratio K inputted into the controlled parameter setting section 73 is respectively carried out with Multipliers 732A and 732B, and it is respectively inputted [gain / Ksi0 / of the example gain 0 and Ksp 734 of a critical ratio of 733 / criteria integral] into sample hold circuits 731A and 731B with a timing signal flg2. In sample hold circuits 731A and 731B, the output signal of Multipliers 732A and 732B is held at the

moment of a timing signal flg2 being respectively set to "1" from "0", and a controlled parameter (proportional gain Ksp, integral gain Ksi) is outputted.
[0023] The operation shown by (several 4) performs a controlled parameter.
[0024]
Ksp=K-Ksp0 Ksi=K-Ksi0 ..... (4)
The automatic correction of the controlled parameter of the speed-control section 6 is made using this controlled parameter (Ksp, Ksi).
[0025] Next, this example of a series of of operation is shown in drawing 7 and drawing 8 .
[0026] The example of drawing 7 of operation is a thing when not performing online auto tuning (Ksp=Ksp0, Ksi=Ksi0), in order to see the effectiveness of the online auto tuning section 7 which is the description of this invention. In this example of operation, since it is carrying out by 5 times the simple substance inertia value Jm0726 of the motor 1 which shows a load inertia value to drawing 1 , the synthetic inertia value J becomes 6 times. When it carries out adjustable [of rate command value N*] by operation pattern which is illustrated, it turns out that the flattery nature of a rate N has deteriorated.
[0027] Here, the example of drawing 8 of operation is a thing at the time of performing the online auto tuning which is the description of this invention (Ksp=K-Ksp0, Ksi=K-Ksi0). Auto tuning is started from c points. It turns out [whose presumed inertia ratio K is a real inertia ratio (J/Jm0)] that is converged 6 times promptly. Furthermore, by correcting the controlled parameter of the speed-control section 6 also shows that the rate N follows rate command value N* well.
[0028] said example ****** -- inertia presumption -- working -- setting -- the auto tuning method about [when load torque is fixed] -- it is -- inertia presumption -- if it sets working and load torque is changed, an error will arise in signal deltaIq* which is an "acceleration-and-deceleration torque component", and, as a result, inertia presumption precision will fall.
[0029] Then, a control-point-setting constant is corrected using the presumed inertia ratio K calculated when torque fluctuation was below a predetermined value, without using the presumed inertia ratio K then calculated, when load torque estimate is computed using rate command value N* and torque current command value Iq* in drawing 1 , and the presumed inertia ratio K and the torque fluctuation beyond a predetermined value is detected during inertia presumption actuation. Inertia presumption precision can be made high by performing this load torque fluctuation compensation.
[0030] This example is shown in drawing 9 . This example is an example which formed the load torque fluctuation detecting element 74 in the online auto tuning servo control of the motor of drawing 1 , and applied load torque fluctuation compensation to it. In drawing, 1-6, and 71 and 73 are the same objects as the thing of drawing 1 . 74 is a load torque fluctuation detecting element which detects torque fluctuation using rate command value N* and torque current command value Iq*, and the presumed inertia ratio K, and an output signal flg3 is as follows.
[0031]
負荷トルクの変動を検出した場合　: $flg_3 = 1$
〃　を検出しない場合　: $flg_3 = 0$

Next, the load torque fluctuation detecting element 74 which is the characteristic configuration of this invention is explained using drawing 10 . Rate command value N* inputted into the load torque fluctuation detecting element 74 is inputted into a differentiator 746, the output is inputted into multiplier 745A with the simple substance inertia value Jm0 of the motor 1 of 747, and both the output and the presumed inertia ratio K are inputted into multiplier 745B, by multiplier 745B, they output "estimate of acceleration-and-deceleration component" signal taum, and are inputted into a subtractor 741 with torque current command value Iq*. The output of a subtractor 741 is set to "estimate of load torque component" signal tauL, it is inputted into an absolute-value circuit 742, and the output is inputted into the first-order-lag circuit 743.
[0032] With the output of an absolute-value circuit 742, the output of the first-order-lag circuit 743 is inputted into a subtractor 744, and the output deltatauL is inputted into a comparator 749 with the load torque change width-of-face set point deltatauLset of 748. The signal flg3 outputted in a comparator 749 is as follows.
[0033]
deltatauL>deltatauLset Case: flg3= 1 deltatauL<=deltatauLset Case: flg 3= 0 -- further -- inertia presumption section

72A -- inertia presumption -- being working (section of flg 1 = 1) -- when flg 3= 1 is detected, the presumed inertia ratio K calculated at the time of flg 3= 0, without using the presumed inertia ratio K calculated at this time is used.
[0034] Next, this example of a series of of operation is shown in drawing 11 and drawing 12 .
[0035] The example of drawing 11 of operation is a thing at the time of not performing load-effect compensation, in order to see the effectiveness of load-effect compensation which is the description of this invention (when deltatauLset of the load torque change width-of-face set point 748 shown in drawing 10 is set to 300 [%]). In this example of operation, the load torque of 100 [%] is impressed in d in inertia presumption actuation. d-point after -- setting -- the presumed inertia ratio K -- 6 times of a true value -- being excessive (9 times) -- it turns out that it has become.
[0036] Here, the example of operation at the time of applying this invention is shown in drawing 12 . Drawing 12 is a thing at the time of performing load-effect compensation which is the description of this invention (it being deltatauLset 10 [%]). Also in this example of operation, the load torque of 100 [%] is impressed in d'point under inertia presumption actuation. this example of operation -- d' -- since it is being completed by the presumed inertia ratio K 6 times of a true value after a point, inertia presumption precision can be made high by performing load torque fluctuation compensation.
[0037] Moreover, said example is an auto tuning method when torque current command value Iq* has not reached during inertia presumption actuation at a current-limiting value, and if torque current command value Iq* reaches during inertia presumption actuation at a current-limiting value, inertia presumption precision will fall like a last example.
[0038] Then, a control-point-setting constant is corrected using the presumed inertia ratio K calculated when torque current command value Iq* was below a current-limiting value, without using the presumed inertia ratio K then calculated, when torque current command value Iq* in drawing 1 reaches a current-limiting value. Inertia presumption precision can be made high by performing this torque current-limiting compensation.
[0039] This example is shown in drawing 13 . This example is an example which formed the torque current-limiting detecting element 75 in the online auto tuning servo control of the motor of drawing 9 R> 9. In drawing, 1-6, and 71, 73 and 74 are the same as that of the thing of drawing 9 . 75 is a torque current-limiting detecting element which detects current limiting using torque current command value Iq*, and an output signal flg4 is as follows.
[0040]
When current limiting is detected : :flg4= when flg4= 1 current limiting is not detected The torque current-limiting detecting element 75 which is the characteristic configuration of this invention is explained to zero-order using drawing 14 . Torque current command value Iq* inputted into the torque current-limiting detecting element 75 is inputted into an absolute-value circuit 751, and the output is inputted into a comparator 753 with torque current command limiting value Iq*lim of 752. The signal flg4 outputted in a comparator 753 is as follows.
[0041]
| Iq*|>=Iq*lim: flg 4= 0 -- further -- inertia presumption section 72b -- inertia presumption -- being working (section of flg 1 = 1) -- when flg 4= 1 is detected, use the presumed inertia ratio K computed at the time of flg 4= 0, without using the presumed inertia ratio K calculated at this time. Case: flg4= 1|Iq*|<Iq*lim Case
[0042] In this invention, even when torque current command value Iq* reaches during inertia presumption actuation at a current-limiting value, inertia presumption precision can be made high by performing torque current-limiting compensation.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the online auto tuning servo control of the motor which is one example of this invention.
[Drawing 2] It is the explanatory view of the timing setting section in the equipment of drawing 1 .
[Drawing 3] It is the explanatory view of single string actuation of the timing setting section in the equipment of drawing 1 , the inertia presumption section, and the controlled parameter setting section.
[Drawing 4] It is the explanatory view of the inertia presumption section in the equipment of drawing 1 .
[Drawing 5] It is the explanatory view of the presumed acceleration-and-deceleration torque operation in the equipment of drawing 1 .
[Drawing 6] It is the explanatory view of the controlled parameter setting section in the equipment of drawing 1 .
[Drawing 7] It is an example of operation at the time of acceleration-and-deceleration operation of the motor which does not apply this invention.
[Drawing 8] It is an example of operation at the time of acceleration-and-deceleration operation of the motor which applied this invention.
[Drawing 9] It is the block diagram of the online auto tuning servo control of the motor which are other examples of this invention.
[Drawing 10] It is the explanatory view of the load torque fluctuation detecting element in the equipment of drawing 9 .

[Drawing 11] It is an example of operation at the time of acceleration-and-deceleration operation of the motor which does not apply this invention.
[Drawing 12] It is an example of operation at the time of acceleration-and-deceleration operation of the motor which applied this invention.
[Drawing 13] It is the block diagram of the online auto tuning servo control of the motor which are other examples of this invention.
[Drawing 14] It is the explanatory view of the torque current-limiting detecting element in the equipment of drawing 13 .
[Description of Notations]
1 [... A current control section, 5 / ... A rate detector, 6 / ... The speed-control section, 7 / ... The online auto tuning section, 71 / ... The timing setting section, 72 / ... The inertia presumption section, 73 / ... The controlled parameter setting section, 74 / ... A load torque fluctuation detecting element, 75 / ... Torque current-limiting detecting element.] ... A motor, 2 ... A power converter, 3 ... A current detector, 4

[Translation done.]

* NOTICES *

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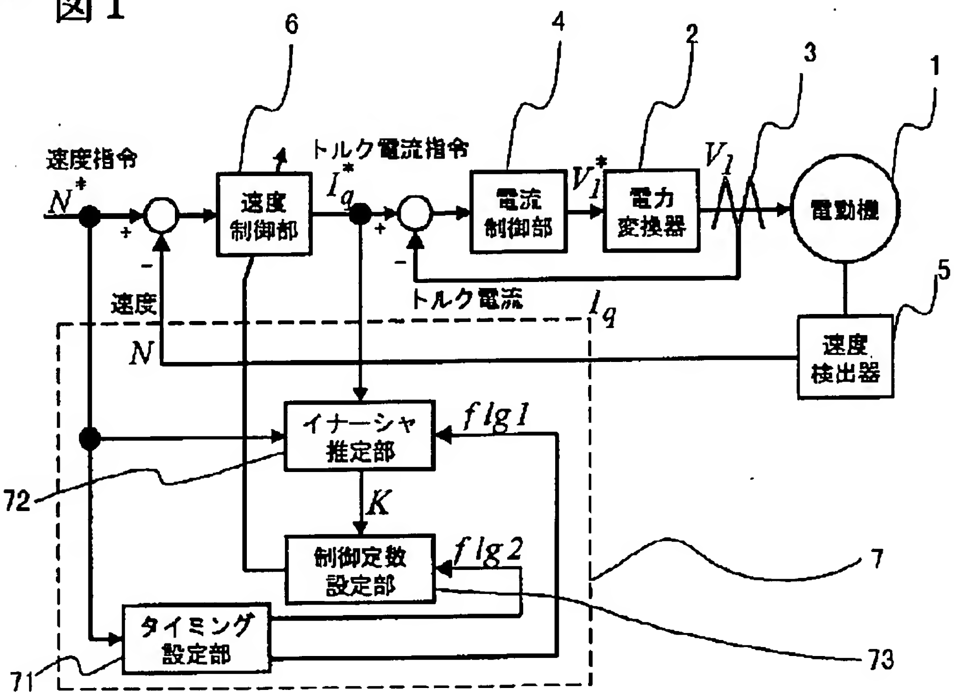
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

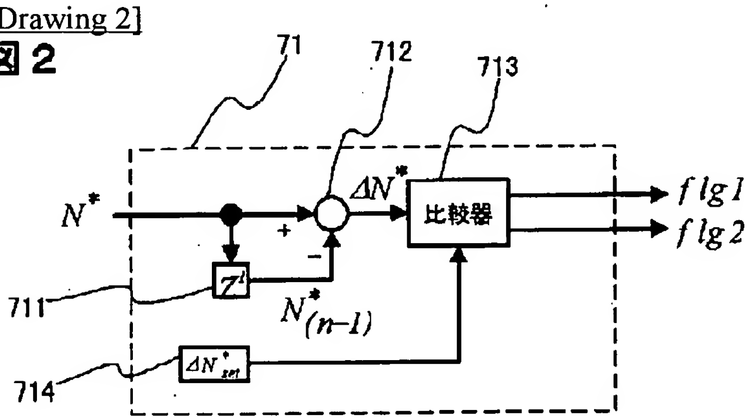
[Drawing 1]

図1



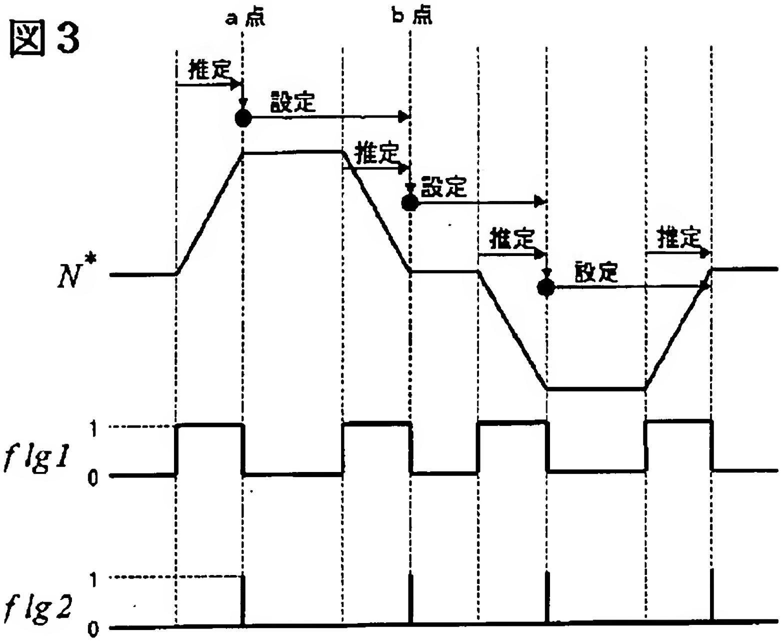
[Drawing 2]

図2



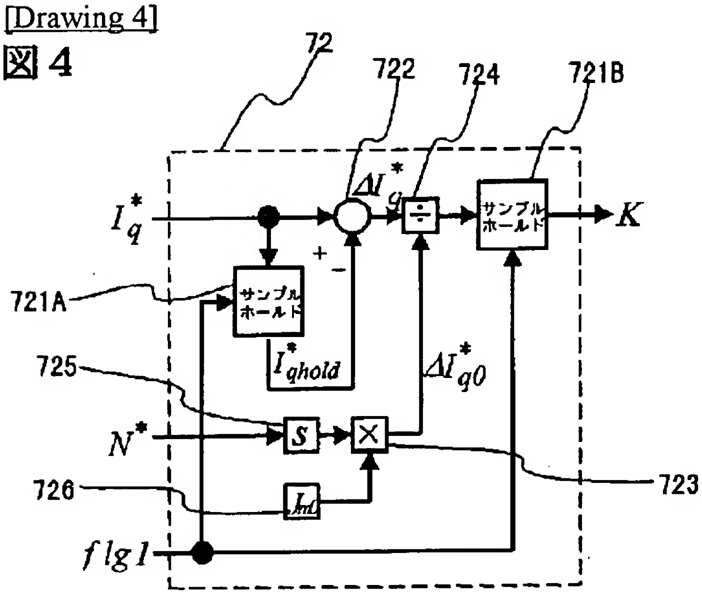
[Drawing 3]

図3



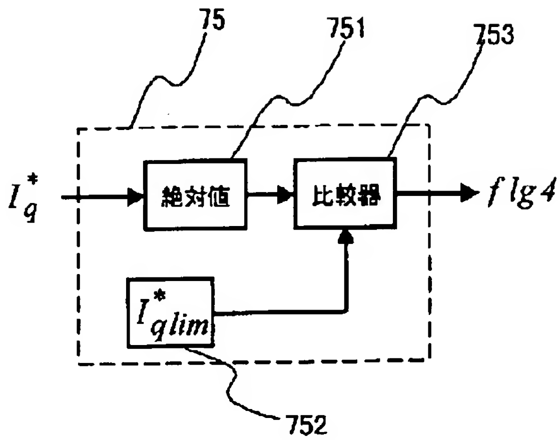
[Drawing 4]

図4



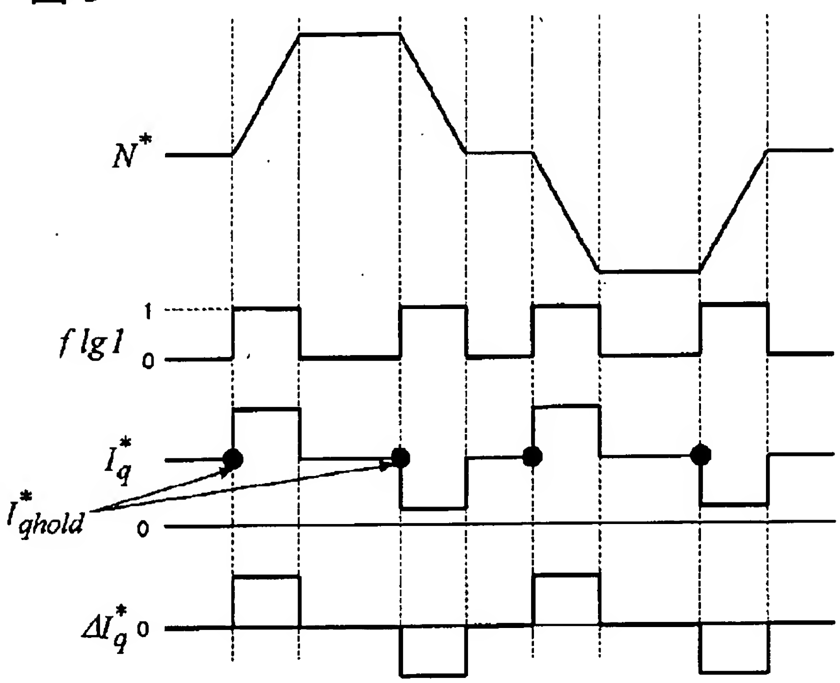
[Drawing 14]

図１４



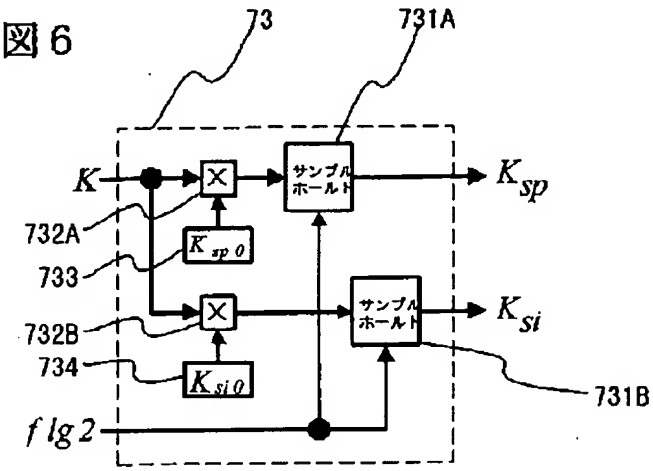
[Drawing 5]

図５



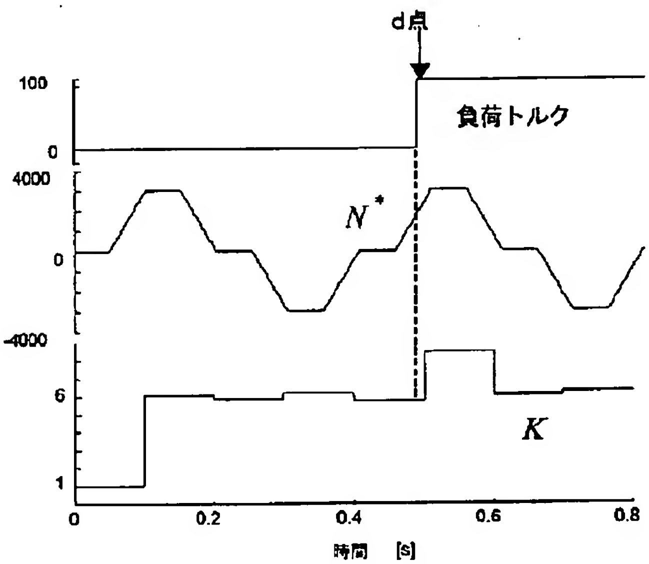
[Drawing 6]

図 6



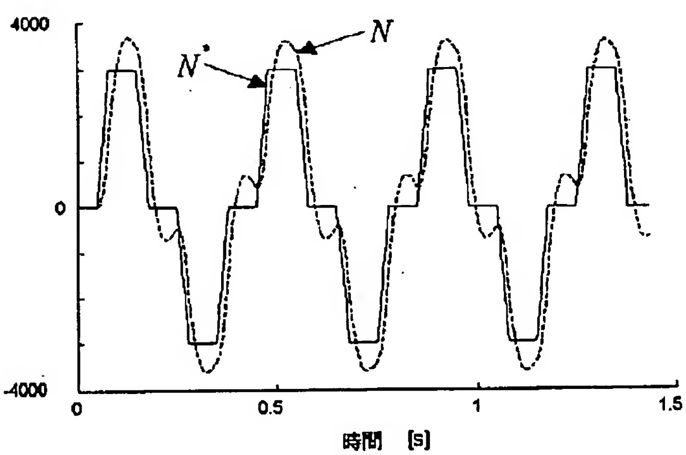
[Drawing 11]

図１１



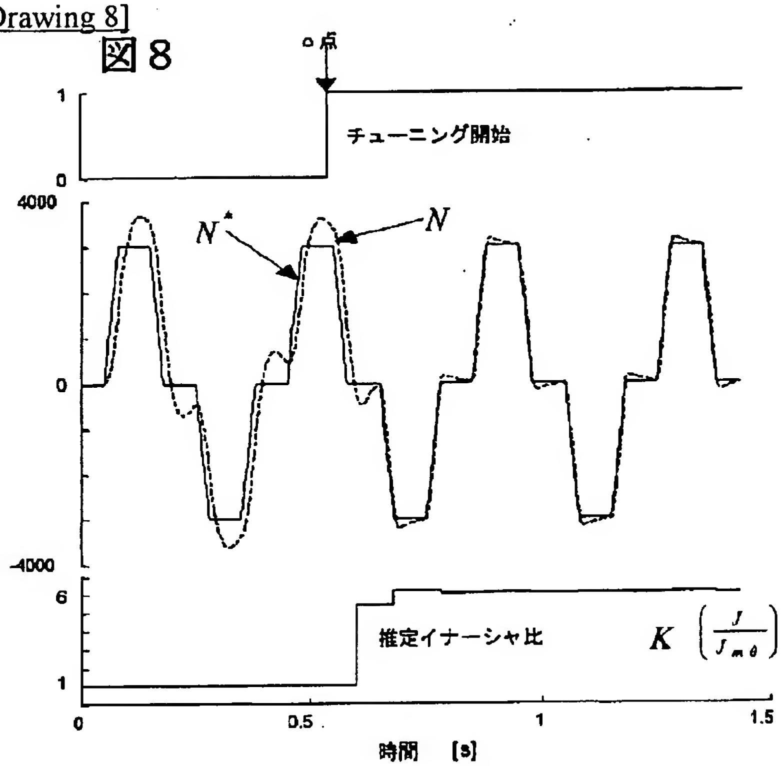
[Drawing 7]

図 7



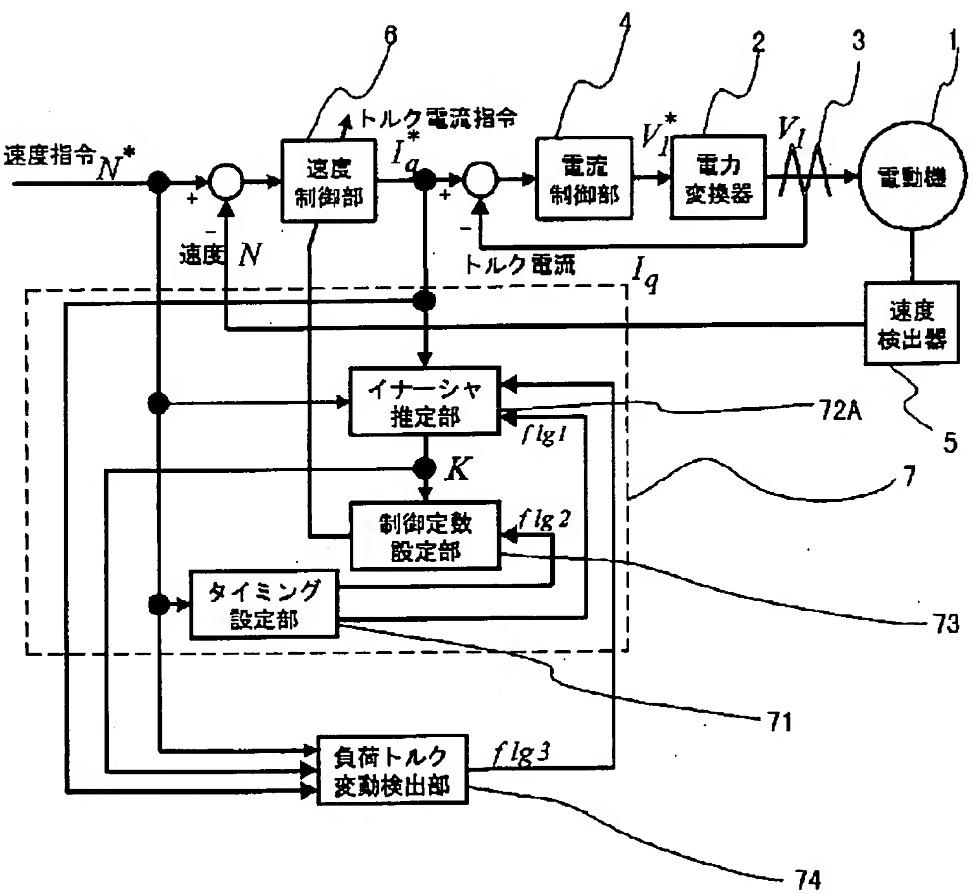
[Drawing 8]

図 8



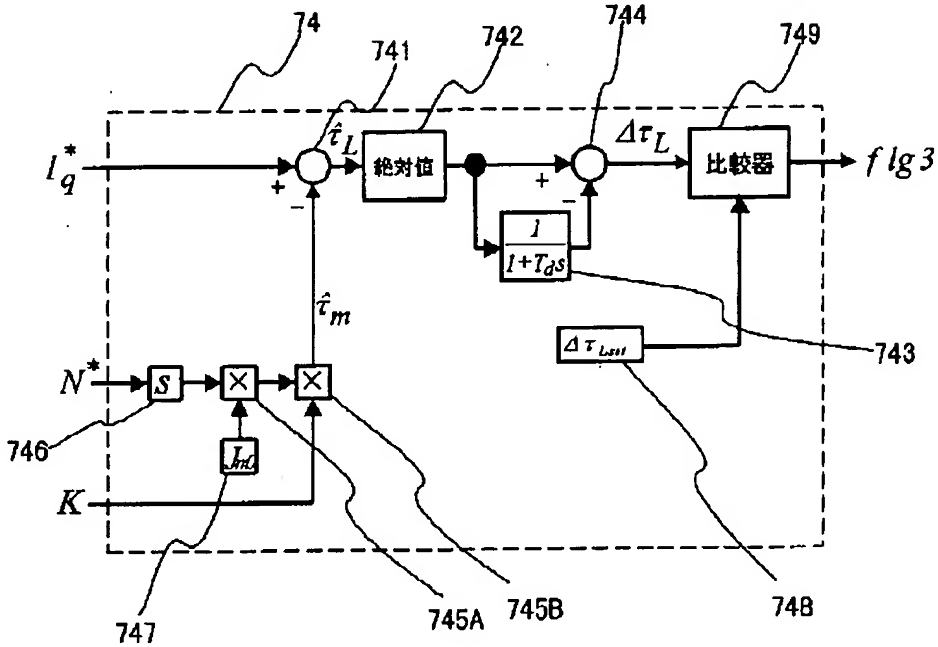
[Drawing 9]

図 9



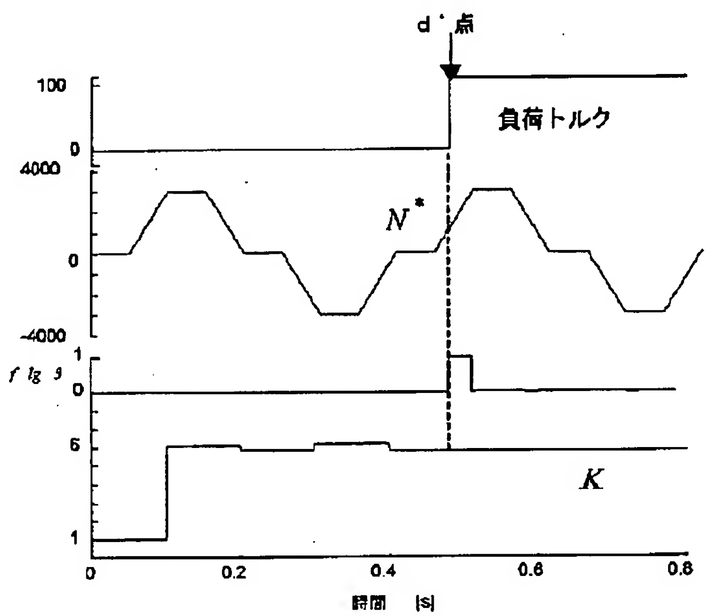
[Drawing 10]

図１０



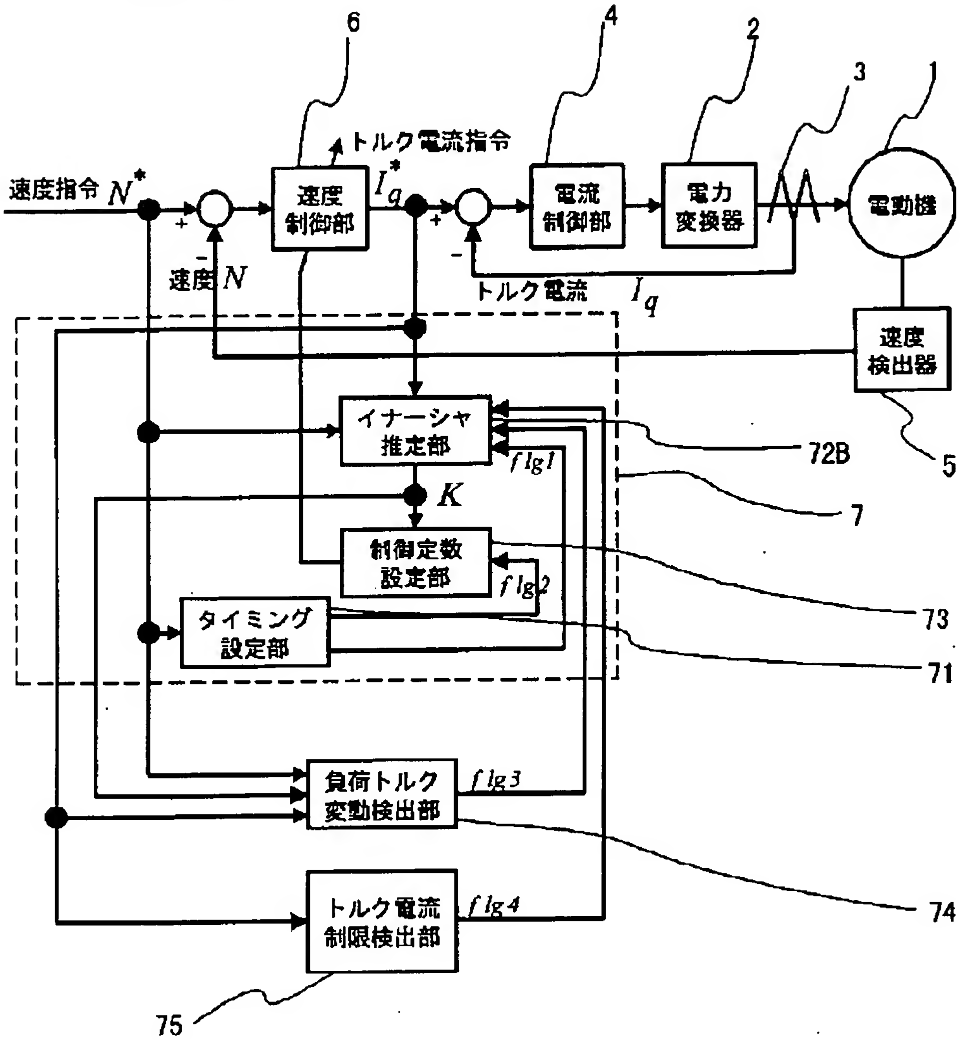
[Drawing 12]

図１２



[Drawing 13]

図１３



[Translation done.]